CLAIMS

What is claimed is:

1. A color signal processing device, comprising:

a display unit;

a luminance_color difference signal conversion unit converting an input image signal into a luminance_color difference signal;

a change rate detection unit detecting a change rate of a color difference signal when the color difference signal changes with hue and luminance remaining constant in a color space of the luminance_color difference signal;

an RGB color signal conversion unit converting the luminance_color difference signal into an RGB color signal, wherein the display unit displays the RGB color signal;

a detection unit detecting the RGB color signal changing in a color space of the RGB color signal according to the changes of the color difference signal; and

a color gamut decision unit determining a color chroma scope based on a change rate of the RGB color signal according to the change rate of the color difference signal when the detected RGB color signal exists on a color space boundary of the RGB color signal and displaying the color chroma scope on the display unit.

2. The color signal processing device as claimed in claim 1, wherein the luminance_color difference signal conversion unit converts the image signal into any one of a YCbCr signal, a YIQ signal, and a YUV signal.

3. The color signal processing device as claimed in claim 1, wherein the luminance_color difference signal conversion unit converts the image signal into a YCbCr color signal.

4. The color signal processing device as claimed in claim 3, wherein the RGB color signal conversion unit converts the luminance_color difference signal into the RGB color signal through a matrix as follows:

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = M \begin{pmatrix} Y \\ C_b \\ C_r \end{pmatrix}$$

where M denotes a conversion matrix of 3×3, comprising,

$$M = \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}.$$

5. The color signal processing device as claimed in claim 4, wherein the detection unit detects the changes of the RGB color signal through a formula as follows:

$$R^* = a \cdot Y + b \cdot k \cdot Cb + c \cdot k \cdot Cr = a \cdot Y + k \cdot (b \cdot Cb + c \cdot Cr) = R_{init} + k \cdot \Delta R$$
$$G^* = d \cdot Y + e \cdot k \cdot Cb + f \cdot k \cdot Cr = d \cdot Y + k \cdot (e \cdot Cb + f \cdot Cr) = G_{init} + k \cdot \Delta G$$
$$B^* = g \cdot Y + h \cdot k \cdot Cb + i \cdot k \cdot Cr = g \cdot Y + k \cdot (h \cdot Cb + i \cdot Cr) = B_{init} + k \cdot \Delta B$$

wherein, $R_{init} = a \cdot Y$, $G_{init} = d \cdot Y$, $B_{init} = g \cdot Y$, k denotes a change rate of the color difference signal, $\Delta R = (b \cdot Cb + c \cdot Cr)$, $\Delta G = (e \cdot Cb + f \cdot Cr)$, $\Delta B = (h \cdot Cb + i \cdot Cr)$, and R^*, G^*, and B^* denotes the RGB color signal converted by the RGB color signal conversion unit.

6. The color signal processing device as claimed in claim 5, further comprising:

a change rate calculation unit calculating the charge rate of the RGB color signal when the RGB color signal changes according to the changes of the color difference signal and exists on a color space boundary of the RGB color signal.

7. The color signal processing device as claimed in claim 6, wherein the change rate calculation unit calculates a change rate of the RGB color signal through a formula as follows:

$$k_R = \frac{R^* - R_{init}}{\Delta R}; k_G = \frac{G^* - G_{init}}{\Delta G}; k_B = \frac{B^* - B_{init}}{\Delta B}$$

wherein, k_R denotes a change rate of a red color(R) signal, k_G denotes a change rate of a green color(G) signal, and k_B denotes a change rate of a blue color(B) signal.

8. The color signal processing device as claimed in claim 7, wherein the color gamut decision unit comprises a minimum change rate selection unit selecting a minimum change rate of the change rates, k_R, k_G, and k_B, of the RGB color signal, which are calculated by the change rate calculation unit, and the color gamut decision unit determines the chroma scope based on the selected minimum change rate.

9. The color signal processing device as claimed in claim 8, wherein the color gamut decision unit determines the chroma scope based on an inverse number of the minimum change rate selected by the minimum change rate selection unit.

10. A color signal processing method, comprising:

converting an input image signal into a luminance_color difference signal;

detecting a change rate of a color difference signal when the color difference signal changes with hue and luminance remaining constant in a color space of the luminance_color difference signal;

converting the luminance_color difference signal into an RGB color signal;

displaying the RGB color signal;

detecting the RGB color signal changing in a color space of the RGB color signal according to changes of the color difference signal;

determining a color chroma scope based on a change rate of the RGB color signal according to the change rate of the color difference signal when the detected RGB color signal exists on a color space boundary of the RGB color signal; and

displaying the color chroma scope.

11. The color signal processing method as claimed in claim 10, further comprising:

converting the image signal into any one of a YCbCr signal, a YIQ signal, and a YUV signal.

12. The color signal processing method as claimed in claim 10, further comprising:

converting the image signal into a YCbCr color signal.

13. The color signal processing method as claimed in claim 12, further comprising:

converting the luminance_color difference signal into the RGB color signal through a matrix as follows:

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = M \begin{pmatrix} Y \\ C_b \\ C_r \end{pmatrix}$$

where M denotes a conversion matrix of 3×3, comprising

$$M = \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}.$$

14. The color signal processing method as claimed in claim 13, further comprising:
detecting changes of the RGB color signal through Formula as follows:

$$R^* = a \cdot Y + b \cdot k \cdot Cb + c \cdot k \cdot Cr = a \cdot Y + k \cdot (b \cdot Cb + c \cdot Cr) = R_{init} + k \cdot \Delta R$$
$$G^* = d \cdot Y + e \cdot k \cdot Cb + f \cdot k \cdot Cr = d \cdot Y + k \cdot (e \cdot Cb + f \cdot Cr) = G_{init} + k \cdot \Delta G$$
$$B^* = g \cdot Y + h \cdot k \cdot Cb + i \cdot k \cdot Cr = g \cdot Y + k \cdot (h \cdot Cb + i \cdot Cr) = B_{init} + k \cdot \Delta B$$

wherein, $R_{init} = a \cdot Y$, $G_{init} = d \cdot Y$, $B_{init} = g \cdot Y$, k denotes a change rate of the color difference signal, $\Delta R = (b \cdot Cb + c \cdot Cr)$, $\Delta G = (e \cdot Cb + f \cdot Cr)$, $\Delta B = (h \cdot Cb + i \cdot Cr)$, and R^*, G^*, and B^* denotes the RGB color signal converted by the RGB color signal conversion step.

15. The color signal processing method as claimed in claim 14, further comprising:
calculating a charge rate of the RGB color signal when the RGB color signal changes according to the changes of the color difference signal and exists on a color space boundary of the RGB color signal.

16. The color signal processing method as claimed in claim 15, further comprising:
calculating a change rate of the RGB color signal through a formula as follows:

$$k_R = \frac{R^* - R_{init}}{\Delta R}; k_G = \frac{G^* - G_{init}}{\Delta G}; k_B = \frac{B^* - B_{init}}{\Delta B}$$

wherein, k_R denotes a change rate of a red color(R) signal, k_G denotes a change rate of a green color(G) signal, and k_B denotes a change rate of a blue color(B) signal.

17. The color signal processing method as claimed in claim 16, further comprising:
selecting a minimum change rate of the change rates, k_R, k_G, and k_B of the RGB color signal which are calculated by the change rate calculation step; and
determing the chroma scope based on the selected minimum change rate.

18. The color signal processing method as claimed in claim 17, further comprising:
determining the chroma scope based on an inverse number of the selected minimum

change rate.

19. A color signal processing device, comprising:

a conversion unit converting an input image signal into an RGB color signal;

a change rate calculation unit calculating change rates of the RGB color signal when the RGB color signal changes with respect to change rates of a color difference signal on boundaries of a color space of the RGB color signal; and

a color gamut decision unit determining a displayable scope of color chroma based on the change rates of the RGB color signal with respect to the change rates of the color difference signal and when the detected RGB color signal exists on the boundaries of the color space of the RGB color signal.

20. The color signal processing device as claimed in claim 19, wherein the conversion unit comprises:

a luminance color difference signal conversion unit converting the input image signal into a luminance color difference signal; and

an RGB color signal conversion unit converting the luminance_color difference signal into the RGB color signal.

21. The color signal processing device as claimed in claim 19, further comprising:

a minimum change rate selection unit selecting a minimum change rate from the change rates of the RGB color signal.

22. The color signal processing device as claimed in claim 19, wherein the color gamut decision unit determines the displayable scope of the color chroma of the input image signal to display a color signal identical to the input image signal without a memory to store coordinate values when calculating a chroma scope.

23. The color signal processing device as claimed in claim 20, further comprising:

a change rate detection unit detecting the change rate of the color difference signal when the color difference signal changes with hue and constantly maintaining color and luminance in a color space of the luminance_color difference signal; and

a detection unit detecting the RGB color signal changing in a color space of the RGB color signal according to changes of the color difference signal.

24. The color signal processing device as claimed in claim 21, wherein the color gamut decision unit determines the scope of the color chroma based on the minimum change rate selected by the minimum change rate selection unit.

25. The color signal processing device as claimed in claim 20, wherein the luminance_color difference signal is one of a YCbCr signal, a YIQ signal, and a YUV signal

26. The color signal processing device as claimed in claim 19, wherein the change rate of the RGB color signal refers to a change rate of each of a red color (R) signal, a green color (G) signal, and a blue color (B) signal.

27. The color signal processing device as claimed in claim 19, further comprising:

a display unit connected to the RGB color signal conversion unit and the color gamut decision unit.

28. A color signal processing method, comprising:

converting an input image signal into an RGB color signal;

calculating change rates of the RGB color signal when the RGB color signal changes with respect to change rates of a color difference signal on boundaries of a color space of the RGB color signal; and

determining a displayable scope of color chroma based on the change rates of the RGB color signal with respect to the change rates of the color difference signal and when the detected RGB color signal exists on the boundaries of the color space of the RGB color signal.

29. The color signal processing method as claimed in claim 28, further comprising:

converting the input image signal into a luminance_color difference signal; and

converting the luminance_color difference signal into the RGB color signal.

30. The color signal processing method as claimed in claim 28, further comprising:

selecting a minimum change rate from the change rates of the RGB color signal.

31. The color signal processing method as claimed in claim 28, further comprising:

determining the displayable scope of the color chroma of the input image signal to

display a color signal identical to the input image signal without a memory.

32. The color signal processing method as claimed in claim 29, further comprising:

detecting the change rate of the color difference signal when the color difference signal changes with hue and constantly maintaining color and luminance in a color space of the luminance_color difference signal; and

a detection unit detecting the RGB color signal changing in a color space of the RGB color signal according to changes of the color difference signal.

33. The color signal processing method as claimed in claim 29, wherein the luminance_color difference signal is one of a YCbCr signal, a YIQ signal, and a YUV signal

34. The color signal processing method as claimed in claim 32, wherein the change rate of the RGB color signal refers to a change rate of each of a red color (R) signal, a green color (G) signal, and a blue color (B) signal.

35. The color signal processing method as claimed in claim 34, further comprising:

calculating a color chroma C and a hue H of the image signal using a following formula:

$$C = \sqrt{Cb^2 + Cr^2}$$

$$H = \arctan\left(\frac{Cr}{Cb}\right).$$

36. The color signal processing method as claimed in claim 35, wherein when a color chroma C and a hue H of the image signal are constant, a chroma ratio of the input image signal is expressed as shown:

$$S = \frac{C}{C_{max}}$$

where, S denotes a ratio of the chroma of the input image signal to the maximum chroma (C_{max}).

37. The color signal processing method as claimed in claim 36, further comprising:

converting the luminance_color difference signal comprising a YCbCr signal into the RGB color signal using the following relationship:

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = M \begin{pmatrix} Y \\ C_b \\ C_r \end{pmatrix}$$

Where M denotes a conversion matrix of 3×3, that is,

$$M = \begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix}.$$

and lowercase alphabet letters a ~ i denote elements of the matrix M.

38. The color signal processing method as claimed in claim 37, wherein the detecting of the RGB color signal is expressed as follows:

$$R^* = a \cdot Y + b \cdot k \cdot Cb + c \cdot k \cdot Cr = a \cdot Y + k \cdot (b \cdot Cb + c \cdot Cr) = R_{init} + k \cdot \Delta R$$
$$G^* = d \cdot Y + e \cdot k \cdot Cb + f \cdot k \cdot Cr = d \cdot Y + k \cdot (e \cdot Cb + f \cdot Cr) = G_{init} + k \cdot \Delta G$$
$$B^* = g \cdot Y + h \cdot k \cdot Cb + i \cdot k \cdot Cr = g \cdot Y + k \cdot (h \cdot Cb + i \cdot Cr) = B_{init} + k \cdot \Delta B$$

where, $R_{init} = a \cdot Y$, $G_{init} = d \cdot Y$, $B_{init} = g \cdot Y$, k denotes a change rate of the color difference signal, $\Delta R = (b \cdot Cb + c \cdot Cr)$, $\Delta G = (e \cdot Cb + f \cdot Cr)$, $\Delta B = (h \cdot Cb + i \cdot Cr)$, and R^*, G^*, and B^* denotes the RGB color signal converted by the RGB color signal conversion unit.

39. The color signal processing method as claimed in claim 38, wherein the change rates of the R signal, the G signal, and the B signal of the RGB color signal comprise k_R, k_G, and k_B, respectively, and the RGB color signal is expressed as follows:

$$R^* = R_{init} + k_R \cdot \Delta R$$
$$G^* = G_{init} + k_G \cdot \Delta G$$
$$B^* = B_{init} + k_B \cdot \Delta B$$

40. The color signal processing method as claimed in claim 39, further comprising: calculating the change rates of k_R, k_G, and k_B as follows:

$$k_R = \frac{R^* - R_{init}}{\Delta R}; k_G = \frac{G^* - G_{init}}{\Delta G}; k_B = \frac{B^* - B_{init}}{\Delta B}.$$

41. The color signal processing method as claimed in claim 40, wherein when corresponding change amounts, ΔR, ΔG, and ΔB increase with respect to boundary values of

the RGB color space, R*, G*, and B* are expressed as follows:

$$\text{if}(\Delta R>0)\ R^* = 1;\ \text{else}\ R^* = 0;$$

$$\text{if}(\Delta G>0)\ G^* = 1;\ \text{else}\ G^* = 0;$$

$$\text{if}(\Delta B>0)\ B^* = 1;\ \text{else}\ B^* = 0.$$